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NONDESTRUCTIVE EVALUATION OF AIRPORT PAVEMENTS

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VOLUME III

OPERATION MANUAL FOR MLGPAV PROGRAM AT TCC

BY

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NAI C. YANG & ASSOCIATES, ENGINEERS



SEPTEMBER 1979

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OPERATION MANUAL FOR MLGPAV PROGRAM AT TCC

CONTENTS		Page
OPERATION LOGIC, PROGRAM LANGUAGE AND COMPU	JTER SYSTEM	1
FORMAT OF USER'S INPUT		2
JOB INPUTS Job Card Aircraft Data Group		3 3 3
Program Control Cards Regional Cost Values Facility Types Bandwidth for Traffic Distribution Dynamic Increment of Aircraft Vibration Velocity of Aircraft Financial Cost Data Demand Forecast PFLDI, Smoothness of Existing Pavements Class, Identification for Design Coeffic Layer, Identification for E-value and Pol Layer Cost Data Group Pavement Data Group Pavement Data Group Design Charts - Layer Thickness New Pavement ESUB Grid Values Codes of Keel and Side Existing Pavement Data Group PFLPAV ESUB grid Values PFLPAV Design Charts Control Group Data PFLPAV in Aircraft Equivalency for PFL PAVEMENT in Aircraft Equivalency for Thi Design Charts for Limiting Deflection ar Facility and Station Identifications Statistically Processed NDT Group Data Average Daily Movements Airport Traffic Distribution GELS/NDT3 Design Charts Pavement Design	oisson's Ratio ickness Design	5 5 5 5 5 5 5 6 6 6 6 6 7 7 7 8 8 8 8 9 9 9 9 9 10 10 10 10 10 10 10 10 10 10 10 10 10

	Page
DESCRIPTION OF SYSTEM OUTPUTS	
Title Page	17
Print/Input	17
GELS/FAMD	17
GELS/FAM Page Counter MWFPRT	17
GELS/HDES Page Counter MWPRT	17
Run/PAVDES Page Counter ATM	17
Page Counter OPWGT	17
Page Counter AND/ANS	17
Page Counter CED:	17
Page Counter PAV:	18
ERROR MESSAGES AND DIAGNOSTICS	18
REFERENCES	. 18
APPENDIX 1 OS 360 JOB CONTROL CARDS FO	R OPERATION AT TCC 30
APPENDIX 2 BASIC FORTRAN LISTING	32
Subroutine NDT3	33
Subroutine CALC(1)	34
Subroutine CALC(2)	35
Subroutine PAVDES	36
Subroutine FAM	37
Subroutine HDES	39
Subroutine PCVCAL	42

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OPERATION LOGICS, PROGRAM LANGUAGE, AND COMPUTER SYSTEM

Sensitivity analysis of aircraft parameters on functional pavement design is the primary goal of the MLGPAV program at the Transportation Computer Center (TCC) in Washington, D.C. The program is an integrated system for the functional design of airport pavements. The integrated programs are data independent, based on defined mathematical models and operational logic.

The model parameters, operational details and values to be processed, form a set of input data which is defined through the use of natural language heading statements and requires no programming experience on the part of the user. For the operational program at TCC, the input data is divided into job and universal default inputs. The job inputs consists of only the aircraft data. The default system contains all of the data, independent of the aircraft data.

The primary subsystem is the PAVDES subsystem from the PAVDEN operational program at TCC. The primary output from the PAVDES subsystem is the thickness design of pavements of various compositions. In the PAVBEN operation the aircraft data is in the universal default file and all the associated design charts are in the computed data inputs. For MLGPAV operation, the aircraft data is in the job input file, requiring the necessary design charts to be computed for every execution.

The MLGPAV program is operational on the IBM 360/65 at TCC. The program is written in the high level language FORTRAN IV. The program accepts input in the form of cards and needs several temporary files on auxiliary storage.

FORMAT OF USER'S INPUT

The program accepts input in the form of 80 character cards. The input cards are divided into two types: program control cards and cards in data groups. The control cards specify the program sections to be executed. The data groups provide the actual data values for program processing. Unless otherwise specified, each card is logically divided into eight fields of ten characters each. Each control card has a single keyword in field on which identifies itself both to the program and the user as a control card. Additional fields on a control card are used to provide related information.

Logically related input cards are placed together in data groups. The first card or cards are descriptive heading cards. The number of heading cards is fixed and the user should not add or delete any heading card. One of the heading cards is usually a field identifier card. On this card, each field has an acronym which identifies the data values on subsequent cards in that field. For more detail description, the particular field identifier can be found in the dictionary. Following the heading cards are the cards containing the actual data values corresponding to the field identifier. The order of cards in the group is important. The last card of data group is a delimitor card containing, * * in columns 1 and 2.

Values in a field have three definitions: integer, floating point or alphanumeric. They are expressed respectively by blanks and numbers, 0 to 9; blanks, the minus or plus sign, decimal point and the numbers 0 to 9; and all characters. Certain fields have only specific values allowable. Unless otherwise specified all values should be left justified in a field. This is especially important for alphanumeric fields. Blanks in floating point fields are interpreted as zeros. If a decimal point is omitted in a floating point field, the decimal is assumed to be after the rightmost column in that field. Certain field has subfields. The subfields are separated by slashes, /. The slash must appear in the exact column, as specified. To ensure proper recognization of the control cards and the data groups, the spelling and the spacing of the control keywords and heading descriptions must be correct.

JOB INPUTS

JOB CARD

JOB Starting from column 11 is a 70-character space for job name. Usually SENSITIVITY ANALYSIS OF AIRCRAFT and 9-letter aircraft code.

AIRCRAFT DATA GROUP

FIELD 1 2 3 4 5	IDENTIFIER AIRCRAFT CODE MTOW MLRW OEW RANGE	DESCRIPTION defines index, 1 to 20 defines 9 char. AIRCRAFT code max. take-off weight, 1bs. max. landing roll weight, 1bs. operational empty weight, 1bs. range of aircraft, XLONG, LONG, MEDIUM, or SHORT
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1 2 3 4 5 6 7	BLANK BLANK WHEEL Y-COORD	NWHEEL longitudinal coordinates number of cards is the integer of (NWHEEL-1)/6 plus 1.

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LISTING OF DEFAULT INPUTS

PROGRAM CONTROL CARDS

The user controls the data processing by means of card inputs. All MLGPAV control cards have two portions (1) control keyword field in columns 1 to 10 and (2) specification field or fields in columns 11 to 80 containing values or additional keywords required by the particular control card being used. There are six control keywords which have been programmed in the listing:

Proj	grammed In	rue ripring.
1.	SITE	Starting from column 11 is 4-character site code.
		For TCC operation, this card is in the default system.
2.	LINE	In column 11 is a single digit number indicates the lines
		skipped by the operating system on a printed page. For
		TCC operation, this card is in the default system.
3.	USER	Starting from column 11 is a 12-character user name.
4.	JOBCODE	Starting from column 11 are 7 characters to be printed
		in block letter on title page.
5.	RUN	Field 2 identifies the program to be executed.
6.	PRINT	There are 2 allowable keywords in field 2:
		DICTIONARY - prints all dictionary items in sorted groups.
		INPUT - prints control cards and job inputs.

REGIONAL COST VALUES

FIELD	IDENTIFIER	DESCRIPTION
1	COST	defines cost index 1 to 25
2	CODE	defines 6 character cost code
3	DATE	date of cost values, month/date/year
4	REGION CODE	cost value for the region coded
5	REGION CODE	
6	REGION CODE	
7	REGION CODE	
8	REGION CODE	

There may be more than one data group. Each data group may have one or more regions. The region code is 4 characters long. The cost values of the last region on the last data group will be used in the computations.

FACILITY TYPES

FIELD	IDENTIFIER	DESCRIPTION
1	TYPE	defines index 1 to 5
2	FACILITY	defines 2 character code
3	FACILITY	defines additional 2 character code
4	FACILITY	for example, the first two characters
5	FACILITY	of RUNWAY is the facility type code
6	FACILITY	

BANDWIDTH FOR TRAFFIC DISTRIBUTION

FIELD	IDENTIFIER	DESCRIPTION
1	BANDWIDTH	defines bandwidth index 1 to 5
2+3	CODE	defines 12 character BANDWIDTH code
4	RW	bandwidth in feet
5	TW	bandwidth in feet
6	SH	bandwidth in feet

DYNAMIC INCREMENT OF AIRCRAFT VIBRATION

FIELD	IDENTIFIER	DESCRIPTION
1	DI	facility type location, keel or side
2	RW	dynamic increment, in g
3	TW	dynamic increment, in g
4	SH	dynamic increment, in g

VELOCITY OF AIRCRAFT

FIELD	IDENTIFIER	DESCRIPTION
1	VEL	facility type location, keel or side
2	RW	aircraft velocity in knots
3	TW	aircraft velocity in knots
4	SH	aircraft velocity in knots

FINANCIAL COST DATA

FIELD	IDENTIFIER	DESCRIPTION
1	FINANCE	blank
2	AIRB	annual interest rate of bond
3	ARCD	annual rate of cash discount
4	ASCCC	annual escalation rate of construction cost
5	ASCMC	annual escalation rate of maintenance need
6	NBL	maturity of revenue band in years
7	nslp	mortgage payments of bond, in years

DEMAND FORECAST

FIELD	IDENTIFIER	DESCRIPTION
1	FORECAST	defines 6 char. FORECAST Code
2	ADM	defines 6 char. ADM code
3	ATD	defines 6 char. ATD crue

PFLDI, smoothness of pavement surface

FIELD	IDENTIFIER	DESCRIPTION
1	col. 1-10	defines DI for deflection analysis
2	Col. 11-50	defines 40 char. smoothness description

CLASS, identification for design coefficients

FIELD	IDENTIFIER	DESCRIPTION
1	CLASS	defines CLASS index 1 to 20
2	CODE	defines 6 char. CLASS code
3	OVSFKL	overstress factor for keel
4	OVSFSD	overstress factor for side
5	STRESS	conversion factor from E-value to tensile stress
6	FATIST	coef. of fatigue stress
7	COVAR	coef. of variance
8	A1	coef. of transfer function (trans. to long def.)
1	BLANK	
2	BLANK	
3	A2	ooef. of transfer function (trans. to long def.)
4	D1	coef. of transfer function (elastic to cumulative)
5	D2	coef. of transfer function (elastic to cumulative)
6	DC	coef. of contact rigidity

LAYER, identification for default E-value and Poisson's Ratio

FIELD	IDENTIFIER	DESCRIPTION
1	LAYER	defines LAYER index 1 to 25
2	CODE	defines 6 char. LAYER code
3	EVALUE	default E-value of layer
4	POISSON	default Poisson ratio of layer
5	MOD(S)	mob. and demobilization cost for small job
6	MOD(N)	mob. and demobilization cost for normal work

LAYER COST DATA GROUP

FIELD	IDENTIFIER	DESCRIPTION
1	LAYER	defines LAYER index
2	PCBT	coef. for computing unit price of the layer
3	FIAGT	
4	COAGT	
5	ASCLT	
6	HLBT	
7	POZBT	
8	SFST	

Cont	inuation Card								
1	BLANK								
2	IWFAT	coef.	for	computing	unit	price	of	the	layer
3	RSWLB					•			•
4	LBBR								
5	CLHR								
6	Slehr								

PAVEMENT DATA GROUP

FIELD	IDENTIFIER	DESCRIPTION
1	PAVEMENT	defines PAVEMENT index 1 to 20
2	CODE	defines 6 char. PAVEMENT code
3	LAYER	defines code of layer composition
4	THICKNESS	default thickness of layer, inches
5	EVALUE	if blank, use default E-value
6	POISSON	if blank, use default poisson

Last card in each defined pavement must have a layer code of SUB, PAV or PFLPAV. SUB defines new pavement on subgrade; PAV defines overlay pavement on existing pavement which is treated as one layer; PFLPAV defines overlay pavement on actual existing pavement.

DESIGN CHARTS - LAYER THICKNESSES

FIELD	identifier	DESCRIPTION
1	ITERATE	blank
2	PAVEMENT	PAVEMENT index
3	LAYER	LAYER code
4	HMIN	min. thickness of design chart, inches
5	HMAX	max. thickness of design chart, inches
6	HSTEP	thickness increment of design chart, inches

NEW PAVEMENT ESUB GRID VALUES

FIELD	DESCRIPTION

1 to 8 subgrade E-values of design charts for new pavement

and overlay pavements on actual existing pavement.

Continuation card also has same format. number of cards = the integer of (number of E-values -1)/8 plus 1.

max. number of E-values = 20.

CODES OF KEEL AND SIDE

FIELD	Identifier	DESCRIPTION	
1	PAVEMENT	blank	
2	number	blank	
3	KEEL	defines pavement index for keel	
4	SIDE	defines pavement index for side	

EXISTING PAVEMENT DATA GROUP

FTELL	DENTIFIER	DESCRIPTION
1	PFLPAV	defines PFLPAV index, 1 to 20
2	CODE	defines 6 char. PFLPAV code
3	LAYER	LAYER code
4	THICKNESS	thickness of layer, inches
5	EVALUE	if blank, default value is used
6	POISSON	if blank, default value is used
Each	PFT.PAV must end	with a LAYER code SUB.

PFLPAV ESUB GRID VALUES

FIELD	DE
LILL	DE DE

ESCRIPTION

subgrade E-value for PFLPAV deflection and stress 1 to 8

Continuation card also has same format.

number of cards = the integer of (number of E-values -1)/8 plus 1.

max. number of E-values = 20.

PFLPAV DESIGN CHARTS CONTROL GROUP DATA

FIELD	IDENTIFIER	DESCRIPTION
1	PFLPAV	PFLPAV index
2	CLASS	CLASS code for design coefficients
3	LAYER FOR	-
	STR/MT	LAYER code for governing stress condition

PFLPAV IN AIRCRAFT EQUIVALENCY FOR PFL

FIELD	IDENTIFIER	DESCRIPTION
1	CLASS	CLASS index
2	PFLPAV FOR	
	AND/ANS	PFI.PAV index

PAVEMENT IN AIRCRAFT EQUIVALENCY FOR THICKNESS DESIGN

FIELD	IDENTIFIER	DESCRIPTION
1	CLASS	CLASS index
2	PAVEMENT	PAVEMENT index
3	PFLPAV FOR	
	AND/ANS	PFLPAV index, (0 indicates subgrade)
Both PA	VEMENT and PFLPAV	indexes are used to define the representative
		ircraft equivalency for thickness design.

DESIGN CHARTS FOR LIMITING DEFLECTION AND STRESS

FIELD	IDENTIFIER	DESCRIPTION
1	PAVEMENT	PAVEMENT index
2	PFLPAV	PFLPAV index
3	CLASS	CLASS code
4	LAYER FOR	
	STR/MT	LAYER code for governing stress condition.

FACILITY AND STATION IDENTIFICATIONS

FIELD	IDENTIFIERS	DESCRIPTIONS
1	FACILITY	defines FACILITY index, 1 to 50
2	CODE	defines 9 char. FACILITY code, first 2 char.
		identify facility type code
3	STA-FROM	min. 5 char. station code in hundreds of feet
4	STA-TO	max. 5 char. station code in hundreds of feet

STATISTICALLY PROCESSED NDT GROUP DATA

FIELI) IDENTIFIERS	DESCRIPTIONS
1	FACILITY	FACILITY index
2	STA-FROM	min. 5 char. station code
3	STA-TO	max. 5 char. station code
4	SUMZ	blank
5	EVALUE	NDT E-value from NDT2 AREA-E, psi
6	DRAINAGE	DRAINAGE code, NORM or WET
7	TEMP.	temperature
8	PFLPAV	2 subfields, PFLPAV index, PFLPAV code
Max.	number of STA-FRO	M and STA-TO is 7.

AVERAGE DAILY MOVEMENTS

FIELD IDENTIFIER

Heading Card 1, Columns 11 to 20 contain the 6 char. ADM code. Heading Card 2, defines aircraft movements.

DESCRIPTION

1	AIRCRAFT	AIRCRAFT index
2	year	previous year's traffic
3	year + 1	current year's traffic
4	year + 6	5 year ADM
5	year + 11	10 year ADM
6	year + 16	15 year ADM
7	year + 21	20 year ADM
A11	aircraft indexe	must appear. If aircraft does not ha

ave any traffic than leave columns under the years blank.

AIRPORT TRAFFIC DISTRIBUTION

Heading card 1, columns 11 to 20 contain the 6 char. ATD code.

FIELI) IDENTIFIER	DESCRIPTION
1	FACILITY	FACILITY index
2	STA-FROM	min. 5 char. station code
3	STA-TO	max. 5 char. station code
4	YEAR	year + 1 as defined in ADM
5	TOW%	percentage of take-off
6	LRW%	percentage of landing roll
7	TDW%	percentage of touchdown
VEAD	chould match	the one defined in ADM

TEAR should match the one defined in ADM.

GELS/NDT3 for each PFLPAV in design charts control group data.

FIELD DESCRIPTION

- 1 number of thickness
- 2 number of PFLPAV E-values

Continuation card or cards

1 to 8 surface deflection of PFLPAV under a single wheel having tire pressure = 200 psi and radius 9 inches number of cards = the integer of (number of E-values -1)/8 plus 1.

Continuation card or cards

1 to 8 tensile stress in the governing layer under the same single
 wheel for deflection.
 number of cards = the integer of (number of E-values -1)/8 plus 1.

PAVDES PAVEMENT DESIGN

TDENTTF1ER

FIELD

	IDDINATI IDIN	DEDOKET I TON
1	FACILITY	FACILITY index
2	SERVYR	service year in 5, 10, 15 or 20 years
3	BANDWIDTH	BANDWIDTH index
4	FORECAST	FORECAST code
Control:	s the number of f	acilities which will be printed when the PAVDES
program	is run. Facilit	y number may be repeated to get several different
designs	for the same fac	ility.

DESCRIPTION

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.61

.61

1.3333

1.3333

1.3333

2.00

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.40

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.092

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.15

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2.80

.0170

.0104

.0104

.0125

1.0

1.0

1.0

CCZCTB

C.C/AGR

LCF

50

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61

62

63

64

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67	LAYER	cone	EVALUE	P01550N	400(5)	MODENT		
68	1	ASTOP	2000000.		.0329	.3316		
09	?	LCFA	1100000.		. 3364	.1319		
7.3	3 .	LCFR	600000.		.0051	. 3315		
71	4	LCFC	4 300 00.		.0051	.0315		
72	5	SUR	8000.		.0339	5		
73	6	94V	60000.		.0009	.0005		
74	7			•		•3032		
	•	PCCP	50000000		.0065			
75	A	PCC	_ 4000000.					
76	9	RIG	1500000.		.0045	.3022		
77	10	CTR	200000.		.0038	.0019		
78	11	ASRS	150000.		.0026	. 3314	•	
79	12	ASTR	60000-		.0020	.0011		
80	13	AGRS	40000.		.0017	.00.0	•	
81	14	SSRS	20000.		.0015	. 2008		
82	15	LTSUB	15000.		. ออร์ล	.0015		
83	16	FXPCOV	4500000		•0	.0		
	17				:3	- ···		
84	-	FXACOV	180000.			• •		
85	18	EXPC	30000000		•0	•3		
196	19	FXAC	140000.		• າ	• 0		
37	20	EXRSC	30000•		•0			
3.8	21	EXASA	50000.		•0	• 3		
49	27	PFLPAV	60000.		.0009	. 3305		
90	**					•		
-91	LAYER	PCRT	FIAGT	CCAGT	ASCLT	HLBT	POZBT	SEST
42		IWFAT	RSWLB	LBBM	CLHR	SLEHR		
93	1							
44	•							
95	2	.0102				•	•	
96	e.	*0.105						
97	3	0133						
-	3	.0102						
98								
99	4	0107						
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191	5	.0102	• • •					
102								
103	6	.0102		•				
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113	•							
111	10	.0102		•				
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113	11	.0102						
114								
115	17	.0102		***				
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122								the state of the s
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124	••							
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126	• •	*17107.	*					
	18	0102						
127	10	.0107	•					
12A		0165						•
129	19	.0102						
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112		# 17 B 1/ E						
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	~1	.0102						
134								
115	22	.0107						
136					•		· · · · · · ·	
137	**							

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138
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                              ASTOP
139
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140
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146
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150
                   CC/AGR
                              PCC
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151
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152
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155
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158
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159
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                              LAYER
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163
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104
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165
                               LCFA
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165
         NEW PAVEMENT ESUR GRID EVALUES
167
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168
169
         PAVEMENT NIMAFR
                               KEEL
                                          SIDE
170
171
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172
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173
174
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175
176
                                          THICKNESS EVALUE
                   CODE
                               LAYER
17?
178
                    ACL
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                                          3.
                               EXBSA
179
                               SUB
180
181
         PELPAV ESUB GRID EVALUES
1#2
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45000.
                                          6000.
183
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184
         35000.
                               73030.
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185
         **
         PFIPAV
                               LAYER FOR STR/MT
                    CLASS
146
                    AC/NOR
                               EXRSA
187
188
         **
         CLASS
                    PFLPAV FOR AND/ANS
189
190
191
         **
                               PFLPAV FOR AND/ANS
                    DAVENENT
         CLASS
147
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193
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194
195
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176
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197
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198
         **
199
         PAVEMENT
                    PFIPAV
                               CLASS
                                          LAYER FOR STEAMT
200
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                               AC/NOR
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201
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232
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                               CC/LTA
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203
                    O
                               CC/AGB
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         5
204
                    •
                               LCF
                                          LCFC
235
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FACILITY AND STATION IDENTIFICATIONS
206
         FACILITY CODE
                               STA-FROM STA-TO
207
                    RW 5
                                           093.0
208
                                300.3
                    RW 15
                               000.0
                                           090.0
209
                                           090.0
210
                    RW 35
                               000-0
                                           090.0
211
                    TW 5
                               000.0
                               000.0
                    TW 15
                                           090.0
212
213
                    TW 35
                               000.0
                                           090.0
                                           040.0
                    SH 5
                               000.3
214
                                           090.0
                    SH 15
                               000-0
215
                               000.0
                                           090.0
216
                    SH 35
21/
         STATISTICALLY PROCESSED NOT GROUP DATA
218
         FACILITY STA-FRCM
                                                                                        PELPAV
                               STA-TO_
                                         SUMZ
                                                      EVALUE
                                                                 DRAINAGE TEMP.
219
                                                                                         Q/SUB
223
                    000.0
                               030.0
                                                      5000.
                                                                 NURM
271
                    020.0
                                060.0
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227
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223
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224
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225
                    360.0
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220
                    000.0
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                                060.0
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227
                    030.0
228
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229
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233
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232
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234
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736
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237
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238
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239
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240
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241
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247
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243
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244
                    000.0
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245
                    020.0
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                                                      35000.
                                                                  NORM
246
                    060.0
                                090.0
247
248
         AOM
                    ADMSUG
                                AVERAGE DAILY MOVEMENTS, SUGGESTED
                    MUMBER OF
                                AIRCRAFT
                                          MOVEMENTS
249
                                                             1993
         AJPCRAFT
                                                                             1998
250
                    1977
                                1978
                                           1583
                                                       1988
251
                                15.
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                                                                  30.
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                                           20.
                    15.
252
         **
                    ATRIG
                                AIRPORT TRAFFIC DISTRIBUTION. SUGGESTED
253
         ATO
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                                                      TOWS
                                STA-TO
                                           YEAR
254
         FACILITY
                    STA-FROM
                                           1978
                                                                  1000.
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255
                    300.0
                                030.0
                                                      1000.
                                                                             100.
256
                    030.0
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                                           1978
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257
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258
         Z
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259
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                    960-0
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260
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241
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267
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                                           1978
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263
                    340.0
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                    300.0
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                                                      1777.
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                                030.0
264
                                           1978
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215
                    030.0
                                369.3
266
                    360.0
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                                           1978
                                                      13.
71.7
                    000.0
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26 H
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269
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273
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211
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272
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273	, 7	000-0	030.0	1978	1	•		
274		030.0	060.0	1978	•	1		
215		060.0	093.0	1978	•	31		
276	a	000.0	030.0	1978	1	•		
277		030.0	060.0	1978	•	1		
273		060.0	040.0	1978	•	31		
279	9	000.0	030.0	1978	1	•		
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28.9	16.847	0.648	-21.661	-34.545				
285	**							
290	PAVDES	PAVEMENT	DESIGN					
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292	1	20	2	FAMSUG ~				
293	,	20	2	FAMSUG				
274	3	20	2	FAMSUG				
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304	**		P			****		

DESCRIPTION OF SYSTEM OUTPUTS

TITLE PAGE Print the name of user, MLG-PAV, job name and TCC site. The top and bottom margin of title page is 2 and 1 inch respectively.

PRINT/INPUT Head card of input data groups

- 1. Listing of Default Inputs
- 2. Aircraft Data Group

GELS/FAMD For aircraft 1; with weight, MTOW; pavements AC/NOR, AC/SOU, CC/CTB, CC/AGB, LCF; all wheels and 1 wheel; prints the maximum horizontal stress at the bottom of each pavement layer, and the surface deflection at wheel 0., 0.

GELS/FAM Same as GELS/FAMD except all weights, MTOW, MLRW, MTDW. Under the MWFPRT page counter, a table of stresses at the critical layer and the surface deflection for all pavements is printed. GELS/FAMD and GELS/FAM are used to get a single equivalent operation of aircraft 1, weight MTOW.

GELS/HDES For aircraft 1; weight MTOW; pavements AC/NOR, AC/SOU, CC/CTB, CC/AGB, LCF; different thicknesses of design layer; different E-VALUE of subgrade support; all wheels and one wheel; prints the maximum horizontal stress at the bottom of each pavement layer and the surface deflection at wheel 0., 0. Under the MWPRT page counter, a table of stresses at the critical layer and the surface deflection for all pavements is printed.

RUN/PAVDES

- 1. Under ATM page counter, listing of aircraft movements which is equal to the product of average daily movements and airport distribution for each facility segment during the 20 year design service life. ATM for RW and TW stations 0. 30., 30. 60., and 60. 90. is 1825000., 182500. and 18250. respectively. ATM for SH stations 0. 30., 30. 60., and 60. 90. are 1825., 182.5 and 18.25 respectively.
- Under the OPWPT page counter, lists the MTOW, MLRW and MTDW for aircraft 1.
- 3. Under the AND/ANS page counter, equivalent single type aircraft operation will be listed for each pavement and facility. For each pavement only the first two facility segments are printed.
- 4. Under the CED page counter for each pavement, the computed engineering data relating to aircraft load repetition, E-value of subgrade, deflection and stress limits, and thickness analysis for two drainage and three traffic conditions are tabulated. There are five new pavements AC/NOR, AC/SOU, CC/CTB, CC/AGB and LCF. For each new pavement there are three RW, three TW and three SH facilities having respective E-value of subgrade. Under the NORM drainage condition, the associated ESUB NORM values are 5000., 15000., and 35000. psi. The corresponding ESUB WET values are 3000., 9000., and 21000. psi respectively.

5. Under the PAV page counter, the pavement data relating to functional requirements and governing condition of design are tabulated, similar to the CED listing.

ERROR MESSAGES AND DIAGNOSTICS

The input goes through two stages of processing:

- 1. Identification stage in which the input data group or control card must be recognized. If it is not, then, an error message is printed. All cards are printed and the error is temporarily ignored until the next delimitor ** is encountered. If a control card is mispelled, the next data group will be flagged in error yet the program will assume as if the last card of a data group is in error.
- 2. Data verification in which the program prints a limited number of self-explantory error messages. FORTRAN will print messages if the characters do not match the field, such as type of integer or floating point. FORTRAN will also print execution error messages, such as mispunched, incorrect or missing data.

Error messages printed in the system log at the beginning of each job listing can be referred to the OS 360 Manual. These messages help identify whether the program, JCL or hardware caused the error.

REFERENCES

- 1. Yang, Nai C., DESIGN OF FUNCTIONAL PAVEMENTS, McGraw Hill Book Co., New York, 1972.
- 2. Yang, Nai C., Nondestructive Evaluation of Civil Airport Pavements, FAA-RD-76-83, September 1976.
- 3. Yang, Nai C., Nondestructive Evaluation of Airport Pavements, Volume I, Program References, FAA-RD-78-154 I, September 1979.

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SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

NCNDESTRUCTIVE PAVEMENT EVALUATION

A PARTIAL FULFILLMENT OF THE FAA VALIDATION PROCKAM BY NAI C. YANG AND ASSUCIATES, ENGINEERS, F. THIS IS A PROPRIETARY PRUGRAM DEVELUPED BY NAI C. YANG AND ASSUCIATES, ENGINEERS, PC PRIOR TO FAA VALIDATICN. THE USE CF THIS CCMPUTER PRUGRAM SHALL BE CONFINED TO THOSE APPRUVED BY NAI C. YANG, AND ALSO, THE FAA UNTIL THE PROGRAM CF NONDESIRLCTIVE EVALUATION CF CIVIL AIRPURT PAVEMENTS IS UFFICIALLY ABOPTED AND IMPLEMENTED.

THE FAA UNDER THE PRESENT CONDITION ASSUMES NO RESPONSIBILITIES NOR UBLIGATIONS FROM THE USE OF THE PROGRAM AND THE INTERPRETATION OF 115 UUTPUIS

DEC 13, 1978

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D. YANG

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7 HILLS 1 HILLS 1 Journal 1 Journa	J.251CS J.27543 J.26848 J.26848 J.25637 VANG, EI ALRO PAVO 145.3 124.2 104.2 68.1 75.6 66.0 56.4	G.183 O.181 O.175 GIAEER CRAFT: EMENT: 500 134 129 108 89 70 63 54	19 44 21 11NG 5 5 5 5 5 1-10 10 10 10 10 10 10 10 10 10 10 10 10 1	COM SENS SENS SIGN SLL-	207(134 SIT H 1193762138	IJ IJ I I I I I I I I I I I I I I I I I	O. O	08:08:08:08:08:08:08:08:08:08:08:08:08:0	356 160 933 ALY! RES! IGH' 2. ++: 8 IN! 00. 7.3 3.1 6.1 2.9 3.0 10.7	0.000 000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.	GF R IT 38 21 10 57 64 43 3 3 2	AI ER I 880 000 00 00 00 00 00 00 00 00 00 00 0	IRC 1A. 1000	3:	448.447 T YE 0.00 50 9169423261	L- R 2348 G . 825.0 G . 1.7.9	1011 ASBS	1-1		MhFR		
7 Hith. 7 Hith. 7 - U 10 - U 10 - U 12 - U 22 - U 24 - U 25 - U	J.251CS J.27543 J.26848 J.26848 J.25637 VANG, El ALRO PAVI J.26841 J.24-2 68-1 J.24-2 68-1 J.24-2 68-1 J.24-2 68-1 J.24-2	G.183 O.181 O.175 NGINEER CRAFT: EMENT: 500 134 129 74 63 548 42	1944 21 21 3 5 5 5 5 5 6 6 7 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	COM SENS SENS SIGN SLL-	207(134 SIT H -1 90 9133375243833	IS IN TAIL IN THE STANDARD IN	O. O	08:08:08:08:08:08:08:08:08:08:08:08:08:0	356 160 933 ALY: RES: 1GH 2.** 8 1NI 00.7 7.3 7.3 1.1 6.1 2.9 3.2 0.1 6.6	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	GF R IT 38 2 1 10 57 64 33 32 2 2	AI ERI 0000000000000000000000000000000000	IRC 1A. 1000	3:	448.447 T YE 0.00 C 91694232218	L- R 2348 G . 825.00.17.93	1011	1-1		MhFR		
7 HILLS 1 HILLS 1 Journal 1 Journa	J.251CS J.27543 J.26848 J.26848 J.25637 VANG, EI ALRO PAVO 145.3 124.2 104.2 68.1 75.6 66.0 56.4	G.183 G.181 G.175 NGINEER CRAFT: EMENT: 500 1347 128 89 74 63 548 422 38	19 44 21 11NG 5 5 5 5 5 1-10 10 10 10 10 10 10 10 10 10 10 10 10 1	COM SENS SENS SIGN SLL-	207(134 SIT H 1193762138	IJ IVI TAIL IVI AR STUBBLE OF 47991-79037	O. O	08:08:08:08:08:08:08:08:08:08:08:08:08:0	356 160 933 ALY! RES! IGH' 2. ++: 8 IN! 00. 7.3 3.1 6.1 2.9 3.0 10.7	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	GF R IT 38 21 10 57 76 64 33 32 22 11	AI ER I 880 000 00 00 00 00 00 00 00 00 00 00 0	(RC 1A++ 1000)000+++	3:	1 YE 000 CU 91694234434434434434434434434434434434434434	L- R 2348 G . 825.0 G . 1.7.9	1011	1-1		MhFR		

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

				ATM, AIRCRAFT TRAFFIC MOVEMENTS
			STATICA	•
FALILITY	SERVYR	FURECAST	FREM-TO	1-1011-1
Na 15	2C	FAMSUG	C 30.	. TCn:1.825E 06
•		•		LRM: 1.825E 06
				TDn:1.825E 06
KW 13	2 C	FAMSUG	30 60.	. TCh:1.825E 05
				LRW: 1.825E 05
_				TDh:1.825E 05
Km 15	20	FAMSUG	60 50.	TUH: 1.825E 04
				LRn:1.625E 04
				TUn: 1-825E 04
Km 35	2¢	FAMSUG	0 30.	. TGn:1.825E 00
				LRN:1.825E 06
				TON: 1.825E 06
ドロ ン グ	20	FAMSUG	30 60.	. TGm:1.825E 05
				LRN: 1.825E 05
	20	£ 4 4 C 1 C		TDn:1.025E 05
KH 35	20	FAMSUG	04 54.	. TGn:1.825E 04
				LRh:1.825E 04 TDa:1.825E 04
•				TOWN TO COLUMN TO THE TOWN THE PROPERTY OF THE
In 5	20	FAMSUG	0 30-	. TOn:1.825E 06
>				LR#:1.825E 06
				Toh: C.O
10.5	20	FAMSUG	30 60.	. TGm:1.825E 05
• • •				LRW:1.825E 05
÷				TON: C.O
「ゅう	20	FAMSUG	60 50.	. TCh:1.825E 04
		•		LRW: 1.825E 04
				TOW: C.O
In Lo	2 C	FAMSUG	0 30.	10n:1.825E 08
	•			LKW:1.823E GG
				TDA: 0.0
Tn 1>	2 G	FAMSUG	30 60.	TGH:1.825E 05
				LRW: 1.825E 05
	20	E 4 M 5 1 2		TOn:C.O
In 15	20	FAM SUG	ou 40.	TCn:1.825E 04
				LRW: 1.825E 04
				TDh:Q.Q

NAL C. YANG, ENGINEERING CONSULTANT

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

UPERATIONAL AIRCRAFT HEIGHTS

AIRCRAFT CODE RANGE LOAD FACTOR TOW LRW TOW

L-1011-1 LONG 388800. 322200. 483300.

MAI 6. YANG, ENGINEEMING CONSULTANT

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

				EQU	IVALENT	SINGLE T	YPE AIRC	EQUIVALENT SINGLE TYPE AIRCRAFT OPERATION	10v					
Es. Al	Es. AIKCRAFI: L-ICII-I Damumistr: LIGHIS/ILS	-1011-1	height: Forecas	-	388830. LBS : FAMSUG	CLASS:	CLASS: 1/AC/NGR YEAR: 20		FACILITY: RM 5	Ra S				
STATIONS C. 10 30.	ins C. 1		LGCATION: K	KEEL	: !				!			!	1	
7-1101-7		CEFLECTICN CMITERIA 13h LRh 1-CE UO 5-2E-OI 1-86	LEFLECTION CHITERIA AND LRh TON 10h LCC 00 5.26-01 1.46 00 7.26 05 9.56 04 1.26 04	ANG TON 7.2E 05	LRh 9.5E 04	TO: 1.2E 04		STRESS CRITERIA 15m LRh 10m 1Cm LRd 1Ch 1.0E 00 2.6E-01 5.8E 0C 7.2E 05 1.7E C5 1.2E 04	TERIA h 6E-01 5.	3E OC	ANS TCH 7.2E 0	LRA IS 1.7E	TCh C5 1.2E	AANS
,	;	•		7.2E 05	5.5E 04	1.2E 04	8.3E C5	.2E 05 9.5E 04 1.2E 04 8.3E 05			7.ZE 0	5 T.7E	C5.1.2E	7.ZE 05 1.7E C5 1.2E C4 5.CE 05
STATIG	STATIONS 30. TO CC.	0 60.	LOCATION: KEEL	KEEL					•		;			
23	•	ECTION CR	HITERIA	ANG			AAND	STRESS CHIT	ERIA		ANS		:	AANS
1-11011-1		00 5.2E-	01 1.8E 0C	7.2E 04	9.5E 03	8.0E 02	. !	1.CE 00 5.2E-01 1.8E 0C 7.2E 04 9.5E 03 8.UE 02 1.0E 00 2.6E-01 5.8E 00 7.2E 04 1.7E C4 1.2E 03	E-01 5.4	NE 00	7.2E 0	LRW -	75A	
•			•	7.2E 04	9.5E 03	-2E 04 9-5E 03 8-0E 02 8-2E 04	8-2E 04		!	!	7.2E 0	4 1.7E	C4 1.2E	7.2E 04 1.7E C4 1.2E 03 9.0E 04
												• •		

hai L. YANG. ENGINEEKING CONSULTANT

SENSITIVITY ANALYSIS OF AIRCRAFT L-ICLI-1

SUMMARY OF AIRCRAFT FORELAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 helicht: 348400. LBS

PAVEMENT MODEL: COCE LAYER THICKNESS EVALUE PCISSON UNIT-PRICE

d.	!	FA442 hE1	30.2	24.C	17.5	7.4	7 • ¢	4 .0	12.C		7.1	4.	7.	م.	1.6	3,	7°°C	7.4	٠ ٠	7.4	28.€	22.5	16.0	5.8	2.5	J. 4
	LAYER	FAP/2 het	. 9.92		13.5	7	7 · ·	7 ° C	10.4	8.0) • ,	, . , .	7.	7.4	7.6	ۍ ه	4 .	4.	.	2.4		18.6	12.C	9	7.4	A.C
	ASBS	FAN	28.4	22.0	15.5	4.1	4.C	7. C	11.2	8.7	5.0	4.0	4.0	4 ° C	£.	4.0	4.0	4.0	4°C	4.0	27.6	20.0	14.0	4.C	4.0	J. 4
		FAM*2 NGRM	15.8	14.7	9.5	4.	4.0	4.0	16.2	7.7	4.0	6. 0	4.0	0.4	1.1	4.0	0.4	4.0	0.4	D. 4	18.6	13.5	6.8	4.0	0.4	4.0
	THICKNESS OF	FAM/2 NCKM	16.7	11.6	H. H.	4. 0	4.0	4.0	8.7	4.3	4.0	4.0	4.0	4.0	4.2	0.4	4.0	4.0	4.0	0.4	15.5	10.3	7.6	6.0	4.0	4.0
23	; ·	FAX	18.2	13.1	8.8	4.0	4.	4.0	4.5	6.7	4.0	4.0	4.0	0.4	6.7	4.0	4.0	4.0	4.0	4.0	17.1	11.9	8.2	4.C	4.0	4.0
200000. C.150000. O.46000. C.150000. C.150000. C.150000. C.150000. C.1500000. C.15000000000000000000000000000000000000	DES IGN	SERVICE YEARS	20	20	20	70	20	. 07	20	70	70	07	50	0.7	50	50	20	20	70		50	70	50	50	20	20
2.0 6464 8.0 8.0	DEF INED	STRESS	€6.8	102.2	117.5	148.2	167.6	1 40.9	86.8	102.2	117.5	148.2	167.6	186.9	8.08	102.2	117.5	148.2	167.6	186.9	\$0°5	105.7	121.0	152.7	172.0	151.4
ASTOP ASUS AGUS SUB	AND FAR	DEF/HZ	0.2243	0.2461	0.2757	0.4115	0.4776	0.5887	0.1295	0.1421	0.1592	0.2370	0.2754	0.3399	0.0848	0.0936		0.1555	0.1803	0+2225	0.2288	0.2521	0.2843	0.4242	2164-0	0.6279
AC/NOR A	FCH ESUB NORM AND FAM	AAND	828211.	82444.	8210.	8282.	824.	82.	828211.	82444.	8210.	8282	824.	85.	828211.	82444	8210	8282.	824.	82.	466555.	48376.	4820.	4866.	484	48.
	FCH ES	AANS	902088	90206	-1705	. 5539	954	.55	\$02089	90209	9071	9539.	954.	45.	902088	90208	9021	9539.	954.	. 65	529956.	52996.	5300.	5604.	560.	26.
•	!	E SUB NCRN	5000	5000	\$C00•	5000.	5000.	.000 s	15000	15000-	15000.	15660.	15000.	15000.	35000	35000	35000.	35000.	35000.	35000.	5000	\$ 000.	5000	5000.	5000	5000
	:	207	KEEL	KEEL	KEEL	S10E	SIDE	SIDE	KEEL	KEEL	KEEL	S 10E	SIDE	SIDE	KEEL	KEEL	KEEL	SIDE	SIDE	SIDE	KEEL	KEEL	KEEL	310E	\$106	SIDE
	:	STATIGN FRCM-TU	0 30.	30 66.					0 36.		60 90.			.0609	0 36.	33 66.		0 30.			U 30.	30 oc.	.06 09			
	! :	FALILITY	V 4	KA 5	Ka 5	X U	Kn 5	Za V	K# 12	Am 12	Kn Ly	Km 12	Kn 15	Kn 12	25. 45.	•	22	25	A# 32	25	X 2	X 2 V	Ka V	Km v	R. S	KE U

NAI L. YANG, ENGINEERING CONSULTANT

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SUMMARY OF AIRCHAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EGLIVALENT AIRCRAFT GPERATION: L-1011-1 MEIGHT: 3868CO. LBS

PAVENENT MODEL: CODE LAYER THICKNESS EVALUE PCISSON UNIT-PRICE

					₹ ₹	ASBS	* 7		0.50					
					₹ 5	SUB	INFI	•	340					
			•	FCR ESUB	NCKA	AND FAM	CEF INEO			THICKNE				!
FALLLIY	STATION	707	ESUB	AANS	AANO	24/430	STRESS	SERVICE	FAM	FAM/2 FAM+2	FAM+2		FAP/2	FAP \$2
	ACM-TC		NCR			•	ASBS	YEARS	NC X	Z Z	X X Z	ī.	- -	 L
K 5		KEEL	\$ CCO.	993644.	861637.	0.2129	64.9	20	31.2	28.1		36.5	36.5	36.5
× × ×		KEEL	5000-	95364.	85445	0.2335	16.4	50	75.6	20.1	. 25.2	3401	31.4	36.6
\ \ \ \ \ \		KEEL	5000.	.9865	8554.	0.2615	87.9	20	14.6	12.2		24.6	51.5	27.6
κ υ	0 36.	S10 6	5000.	10417.	8616.	6.3503	111.0	50	4.0	4.0	2.0	7.4	٠. د	4.6
K. 5.		SIDE	> 0005	1048.	858	0.4521	125.5	20	4.0	4.0	4.0	7·¢	7 • C	4.6
7		\$10E	2000	105.	86.	0.5571	1.0.1	20	4.0	4.0	4.0	٠,	4.0	4. C
S. I. S.	0- 30-	KEEL	15000	693644	861637	0.1225	6.49	20	7.51	.5.3	12.4	16.3	16.4	20.4
Kh 15	.00 -0	KEEL	15000.	45364	85845	0.1346	16.4	20	6.5	5.3	7.6	12.0	7.01	13.5
Kn 15		KEEL	15000.	9836.	8554	0.1510	87.9	50	4.0	4.0	4.0	6.5	5.1	၁
Kn 12		SIDE	15000.	16417.	8616.	0.2254	0.111	70	7°C	4.0	٥.4	7.	4	7.
KH 15		SICE	15000.	1048.	858	0.2610	125.5	50	4.0	4.0	4.0	J.	٠,	٠,
Ka 15	·0609	SIDE	15000	105.	86.	0.3216	140-1	20	4.0	0.4	0.4	0.4	J.	ۍ ۲
42. 43		KEEL	35600	993644	861637.	2080-0	6.49	20	5.1	4.1	6.1	7.5	3.9	3.1
3	30 60.	K	35000.	95364.	85845	0.0882	16.4	. 50	O.4	0.4	6. 0	4.3	4.0	5.5
45		KEEL	35 COO.	.9855	8554	0.0588		20	4°C	4.0	4.0	9. C	4. C	7. 6
KE 32		SIDE	35000.	10477.	8616.	0.1475	111.0	50	\$.C	9	4.0	٠. د	A.C	٠. ۲
45		SIDE	35000.	1C48.	858	90110		70	4°C	4.0	J. 4	7. C	7.	٠ ٠
Rn 22 6		Stoe	35600 .	105.	96	0:2100	140:1	20	4.0	4.0	4.0	0.4	.	
x v		KEEL	\$000	543743.	506192.	0.2171	67.6	20	25.3	26.7	31.6	36.5	38.5	36.5
X . V		KEEL	5 000.	58374.	50382.	0.2391	19.1	20	20.7	18.2	23.2	3.7£	23.2	14.1
X X V		KEEL	5000.	5637.	5022.	0.2696	.9.05	50	12.8	10.4	15.2	25.2	15.3	25.3
X 5 5		\$10E	5000.	6155.	5062	0.4023	114.3	20	9. C	4 .0	0.	4.	٠,	4.0
ha 2	30 60.	\$10E	5000	616.	504.	0.4711	128.9	20	0.4	4.0	0.4		J••	,) • b
Rnb		SIDE	2000	. 29	50.	0.5937	143.5	50	9	0.4	0.4	4.0	9	J. 4

NAI L. YANG, ENGINEERING CONSLLTANI

SENSITIVITY ANALYSIS OF AIRCRAFT L-ICII-I

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EUDIVALENT AIRCRAFT GPERATION: L-1011-1 hEluht: 386800. LBS

PAVEMENT MODEL: CODE LAYER THICKNESS EVALUE POISSON UNIT-PRICE

			; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;		2 ST2/22	PCC CTB SUB	6.0 [NF]	\$000000. 200000. \$***	C. 12 C. 23 G. 34				:	
	i			FCR ES	ESUB NORM	AND FAP	CEFINED		:			ָם עני	4 4 6 6	1
FALILITY	STATICA FRCH-TC	207	ESUB	AANS	AAND	DEF / W 2	STRESS		FAN	FAM/2 NCRM		2 ~	FAP72 hE1	FAP42 hE1
X S V			. 5003.	840312.	625781.	0.3564	330.6	7.0	15.9	15.2	16.6	1.6.5	17.7	3.51
7 2 7	30 60.	. KEEL		84031.	62169.		383.3	50	13.8	13.3	Ţ	16.0	15.4	16.1
Kn V				8403.	BIBU.		436.0	707	12.2	11.8	17.7	14.1	13.7	14.1
N 8 %				8429.	8258.		551.7	20	2.5	9.3	0	7.11	3€91	11.6
Ka S				843.	822.	0.8478	618.4	26	8.6	E • B	,	5.6	9·6	10.3
KA 2				84.	82.		685.1	50	8.0	8 0	8.0	8.5	8.6	9.2
K# 1.5			15000	840312	825781.	0.2056	330.6	70	11.5	11.4	12.4	13.5	12.5	14.1
CT EV	30 66	. KEEL		84031.	82169	1	383.3	20	10.4	10.0	10.8	11.6	11.4	12.3
			_	8403	8180.		436.0	20	5.1	8.8	9.5	10.5	10.1	10.6
Ka 12			E 15000.	8429	8258		551.7	70	5. €	ວ•8	9°C	6.2		9.6
			_	843.	822.	9		20	9 0	8.0	8.0	9°C	9.0	ð.6
			_	84.	. 82.			20	ω •	8.0	8.0	8 . C	9 - 0	g•c
Ke 45			35000	840312	825781.	0.1347	330.6	02	7.5	5.3	TC.1	10.9	10.5	11.4
				84031	62169.		•	20	4.8	8°C	8.7	\$. \$.	3.5	5.5
X8 32	0609		•	8403.	8180.			20	0.8	0.8	0.8	P • 4	8.1	8
				8429.	8258			50	£. C	8.0	ဘ စ	٤٠	٠ •	ъ. Э.
				843.	822.			50	ပ ဆ	8.0	0 • R	သ အ အ	ာ	8 • 0
	.0609	s SIDE	E 35000.	86.	82.		685.1	20	8.0	9.0	၁ စ	e• c	E.C	9 • 0
un H				493664	485127	0,3636	342.7	.20	15.3	14.7	16.0	17.6	17.1	18.6
				46366-	48210		355.4	50	13.4	12.5	13.5	15.6	15.0	16.2
		_		4937	4802		448.2	20	5-11	11.5	12.3	13.8	13.3	14.3
S #4				4952	4851.		567.1	50	5.6	9.1	8.6	16.5	10.5	11.3
X	30 66.	. S10E	E 5003.	495.	482.		633.8	20	8.3	6.1	9.6	2.5	5.3	7.01
Z Z			!	50.	*8*	1-1163	700.5	07	.0.8	8.0	8.0	1:3	8.4	5.8

HAI L. YANG, ENGINEERING CCNSLLTANT

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

PAVEMENT ACDEL: CCDE LAYER THICKNESS EVALUE PCISSON UNIT-PRICE

EQUIVALENT AIRCRAFT CPERATION: L-1011-1

ME IGHT: 386800. LBS

					CC/AGB P	PCC AGUS SSUS SUB	# 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	400000° 40000° 20000° 20000°	C. 12 C. 28 C. 31 C. 34					
FALILITY	STATICA	201	ESUB	FOR ESUB	LB NÜKM AAND	AND FAM LIMIT DEF/WZ	DEFINED LIMIT STRESS	DES 16R SERVICE	FAM	THICKNESS OF FAM/2 FAM#2	ESS OF FAN+2	PCC	LAYER FAP/2	
ن :	7 KC#-16	3		777020	14057	0776	1	YEAKS	X .	2 . X X	2 K	-) o c	- J
	30° 10°	KFF	2000	* 0.00 C C	82300		383.5		4.4	3,0	15.0	16.6	• "	17.7
K		KEEL	5000	8386	8194		436.0	20	12.9	12.5	13.3	14.7	7.67	15.2
Z Z		SIJE	5000	8551.	8270.		551.2	50	10.4	10.1	10.6	11.8	11.4	12.4
KE J		STUE	5030	855.	823		611.9	5C	5*6	1.6	6.1	1 C. E	10.3	10.5
Y # 7		SIDE	5000°	86.	82.	1.071	1.989	70	8.5	8.3	3 3	2.6	5.3	6.6
K. 15		KEEL	15000	838646.	826953	0.2106	330.6	20	5.21	12.4	13.4	14.3	13.1	14.5
An As	30 66.	Kttl	15000.	83865.	82300°		383.3	50	11.5	1101	11.6	12.6	12.2	13.1
ha 15		XEEL	15000.	8386.	8194		436.0	207	10.3	10.0	10.6	11.3	11.0	11.7
KK 12		SIDE	15000.	E551.	8270.		551.2	20	8.5	8.2	6.7	2.5	6.5	٠ ٢
Kh 12		S10 E	15000.	855.	823.		611.9	20	8. C	ж С	8 0	e.4	£.1	£.6
Rm 15		SIDE	15000	99	85.		684.7	20	0.88	8	8.0	သ ရှ	3°8	3.8
Kn 35		KEEL	35660.	838646.	826953.	6.1375	3.00.6	20	11.4	11.0	11.8	12.2	11.6	12-1
	30 60.	KEEL	3>000.	83865.	82300.		383.3	20	10.2	S. d	10.5	10.9	1C.5	11.2
		KEEL	35600.	8386.	8164		4.36.0	77	5.5	8 • 8	5.5	5 E	٠,	10.1
25 27	0 30.	SIDE	35000.	8551.	8270-	0.2829	551.2	50	8.0		0.8	8.1) ° 2	e.
4A 55		S10 E	35C00.	655.	823.		5-119	97	9 9	B .0	•	6.	£ • £	.
K# 35		SIDE	35000.	86.	82.	0.4048	. 1. 499	.02	8.0	8.0	0.9	ن ھ		2.0
X S		KEEL	5000.	492686.	485816.	0.3722	342.8	02	15.9	15.3	16.6	18.3	17.6	15.5
he 5		KEEL	5000.	49269.	48285	0.4101	395.5	50	14.0	13.6	14.6	16.1	15.5	16.7
4. 5		KEEL	5000.	4927.	4810.		7.844	50	12.6	12.2	13.0	14.3	13.5	14.8
X v		SIDE	>0005	5023.	4858*	-	566.6	50	10.2	7°5	10.5	11.5	11.1	11.5
R. 5		3018	2000	205	483	ö	633.4	- 20	.2.5	5.B	4.5	16.3	10.0	16.7
Ra 5		S10E	5000.	50.	*8*	1-1424	1.007	50	8.4	8.1	8.6	4.5	7.5	2.7

CEC:LCF

NAI L. YANG, ENGINEERING CONSLITANT

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

WEIGHT: 388800. LBS EGUIVALENT AIRCRAFT CPERATIGN: L-1011-1 PAVENENT MCDEL: COGE LAYER THICKNESS EVALUE PUISSON UNIT-PRICE

	:	. !			רכב	ASTOP LCFA LCFB LCFC Sud	2 * 0 0 M	230000. 11000000. 6000000. 4000000.	C. 23 C. 17 C. 19 C. 20 C. 34					
FALILITY	STATION FRCH-TG	707	E SUB	FCR ES	ESUB NORM AAND	AND FAR LINIT DEF/WZ	GEFINED LIMIT STRESS LCFC	DESIGN SERVICE YEARS	N A A A A A A A A A A A A A A A A A A A	THICKNESS FAM/2 FAM NGRM NCR	ESS CF FAMA2 NCRF	LCFA (FAP	LAYER FAP/2 nei	FAPE
Kn 5	.060	KEEL	5630.	848840	835636.	1	82.9	27	2.5	- 8.I	10.5	1342	11.5	14.6
K	30 60.	KEEL	SC00.	84834.	83209.		1.66	50	0.9	2.1	e .	Z.3	۳) ن	10.3
Ke V		KEEL	2 000.	8488	8288.		116.5	50	3.5	O .	4.2	6.4	•	7.2
R. 5		SI0 E	5000.	8839.	8356.		147.0	20	2°C	2.0	ۍ د	7.7	•	3.0
ka s		SIDE	5000.	884.	832.	1659.0	168.3	07	2.0	2.0	2•0	. 2°C	•	2.0
Ra 5		S10E	2000	88	83	0.8625	189.5	20	2.0	2.0	2.0	2.0	7.7	2.0
Ka 12		KEEL	15000.	848840.	835636.	0.1741	85.9	20	2.1	2.0	3.5	5.5	4.6	4.5
hn 12	36 6C.	KEEL	15000.	84884.	63209	0.1510	7.66	50	2.0	2.0	•	3.7	7 - 7	(")
Kn 15	63 90.	KEEL	15000.	8488	8288.	0.2140	116.5	70	2.0	7.0	7.0	2°C	J•7	2.C
Ka 13		SIDE	15600.	6835.	8356.	0.3483	147.0	50	7·0	2.0	2°C	2°C	5• د	2.C
KB LJ	30 66.	301S	15000.	884.	832.	0.4636	168.3	20	7.0	2.0	5.0	7. C	7.7	7.7
	-0609	SIDE	15000	88	.683.	0.4540	199.5	20	2.6	2.0	2.0	2.6		5.
54 J	0 30.	KEEL	35600.	848840.	835636.		82.9	50	2.6	2.0	2.0	2.C	2.6	2.0
		KEEL	35000.	84884.	83209		2.55	20	2.0	7.0	7.0	2°C) • 7	7.0
78 37		KEEL	35c00.	8484	8289.		116.5	50	2.0	2.0	_ 5.0 _	2.5	. 3.2	2.0
Kn 33	0 30.	SIDE	35000.	6639	.935¢	0.2286	147.0	50	7°C	2.0	2.0	2°C	7. 7	2.0
Kn 33		SICE	35000	984	832.	0.2642	168:3	20	2.0	2:0	2.0	2.0	7.2	7.2
An 35	-0609	3015	35000.	• 88	83.	0.3260	189.5	20	2.0	2.0	2.0	2.5	2.C	~
K S		KEEL	5000.	498674.	450917.		86.8	70	8.4	7.4	5.5	12.2	10.5	13.5
X 5 5		KEEL	5000	45867	48828.	0.3388	103.6	20	5.3		6.2	8.5	7.6	5.5
KA V	*96 -*D\$	KEEL	2000	*285°	4866.		120.3	20	3.1	5.5	3.1	5.8	 	6.5
A		3018	2000	5153	4909.	0.6218	151.9	25	2:0	2.0	2.0	2.2	2:2	3.2
Ra S			5000	516.	488	•	173.2	50	2.0	2.0	7.0	7 . c	5. 0	2°C
KE V			2000	. 25	40.	7616.0	196.4		2.0	2.0	2.0	. 5.6	7.	7.5

NAI L. YANG. ENGINEEKING CONSCITANT

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LISTING OF PAVEMENT CESIGN AND CUST ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 388000. LBS

PAVEMENT MCGEL: CGCE LAYER THICKNESS EVALUE PCISSCN UNIT-PRICE

	THICKNESS	16.2	4	, 4 , 5	4.0	4°C	5.4	£.7	ý. 4	2•4	7. 4	J. 4		4°C	. O*4	5. 6.) · · · · · · · · · · · · · · · · · · ·	4.0	11.1	11.9	8.2	7.4	J••	
	PCV 1H		1		i i	:									1 1				-	T		:		
	221				:					:						,								
	AMC				ï							:					!			!				
	FUNCTION GCVERNED	DEF /DI	CIBLET	STR/MI	STRIMT	STR/MT	STR/MT	STR/HT	STR/MT	STR/MT	SIR/MI	STR/NT	STR/MT	STR/NT	STK/HT	STR/MT .	STR/MT	STR/MT	DEF /01	DEF/01	STR/MI	- STR/MT	SIR/HI	
200000. C.23 150000. C.24 40000. C.28	CESIGN SERVICE YEARS	20	200	20	07	70	20	20	20	. 97	20	02	20	20	50	50	50	50	. 20	50	50	- 20	0 2	
2.0 20 8.0 46 1NF1	FCRECAST AIRCRAFT MOVEMENT	FAMSUG	FAMSUG	FAMSUG	FAMSLG	FAMSUG	FAMSUG	FAMSUG	FAHSUG	FAMSUG	FAMSUG	FAMSUG	FAMSUG	FAMSC	FAMSUG	FAMSUG	FAMSCG	FAMSUG	FAMSLG	FAMSUG	FAMSUG	FAMSUG	FAMSUG	
IGR ASTUP ASBS AGBS SUB	AIRPURI NAVIGATIĆN SYSTEM	TIGHTS/1LS	L 16h1 5/11.5	LIGHTS/1LS	LIGHTS/1LS	L 1GHTS/1LS	LIGHTS/ILS	LIGHTS/ILS	LIGHTS/ILS	LIGHTS/ILS	L 16HT 5/1LS	L16H15/1LS	L16+15/1L5	L 16hT S/1LS	L16H15/1LS	L 16HTS/1LS	L16HTS/1L5	L16H15/1LS	NGRM/VISUAL	NORM/VISUAL	NGRM/VISUAL	NCRM/VISUAL	NORM/VISUAL	
AC/NGR	ESUE NCPR ++++	5000	2000	5000	5000	5000	15000.	15000	15000.	15000.	15000.	15000.	35000.	35coc.	35000.	35000.	35000	35000.	5000	5000	5000	500C	50CC.	
	VEL	145.	145	145	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	145.	
	10	0-12	71-0	0.18	0.18	61.0	0.12	0.12	0.12	0.18	0.18	0.18	0.12	0.12	0.12	0.18	0.18	0.18	0.12	0.12			0.18	
	227	KEEL	KFF	SIDE	SIDE	S 10E	KEEL	KEEL	KEEL	SIDE	SIDE	SIDE	KEEL	KEEL	KEEL	S10E	SIDE	SIDE	KEEL	KEEL	KEEL	SIDE	SIDE	1
	STATIGN FRCM-TU	0 36.	30°1 00°				0 30.					•06 0g•						·0609			60 90.		30 60.	,
	FACILITY	N of	2 2 2 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1	٠. د د	X	X S	VH 12	KM LO	KM AD	Kn 12	Rn 12	Kn 12	נכ מע	na Jj			X JU	*	ka u	X .	T Z	X . V	× ×	

The program set-ups consist of a single procedure, MLGPAV. The procedure may be stored on a permanent data set and referenced through use of the PROCLIB DD card. If not stored, then an instream procedure on cards is necessary. The following is the deck necessary for executing the MLGPAV program at TCC:
//JOBNAME JOB
Instream procedure or //PROCLIB DD
// EXEC MLGPAV, TIME.MLGPAV=150
//MLGPAV.INPUT DD *
Job card
Aircraft data group
/*

The procedures assume the load module data set, DYLM and the default input data set, DYDT are on a single removable 3330 disk pack D0012. Several temporary data sets, as required, are allocated on any 2 available scratch packs. The temporary data sets may be placed on the pack, D00012, but the wall clock execution time will increase due to arm contention.

JOB CONTROL CARDS

```
//MLGPAV PROC
//MLGPAV EXEC PGM=GOL, REGION=290K
//STEPLIB DD DSNAME=DYLM,DISP=SHR,UNIT=3330,
// VOL=(PRIVATE, RETAIN,,, SER=D00012)
//FT03F001 DD DSNAME=DYDT,DISP=SHR,UNIT=3330,VOL=SER=D00012
//FT04F001 DD DDNAME=INPUT
//FT05F001 DD UNIT=(SYSDA,SEP=STEPLIB),VOL=(PRIVATE,RETAIN),
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT06F001 DD SYSOUT=A
//FT07F001 DD UNIT=SYSDA.VOL=REF=*.FT05F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT08F001 DD UNIT=SYSDA.VOL=REF=*.FT05F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT09F001 DD UNIT=(SYSDA, SEP=(STEPLIB, FT05F001)), VOL=(PRIVATE, RETAIN),
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT10F001 DD UNIT=SYSDA, VOL=REF=*.FT05F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT11F001 DD UNIT=3330, VOL=SER=D00012,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT12F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT13F001 DD UNIT=3330, VOL=SER=D00012,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT14F001 DD UNIT=SYSDA, VOL=REF=*.FT05F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT15F001 DD DUMMY
```

```
//FT16F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT17F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT18F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT19F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT20F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT21F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT22F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT23F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT24F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT25F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT26F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT27F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT28F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001.
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT29F001 DD UNIT=SYSDA.VOL=REF=*.FT09F001.
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT30F001 DD UNIT=SYSDA, VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT31F001 DD UNIT=SYSDA, VOL=REF=*.FT05F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT32F001 DD UNIT=SYSDA, VOL=REF=*.FT05F001,
// SPACE=(CYL,(4,4)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
// PEND
```

APPENDIX 2

BASIC FORTRAN LISTING

A2.05	SUBROUTINE NDT3 Compute NDT inventory file
A2.06	SUBROUTINE CALC(1) Compute Poisson's Ratio, and aircraft operational weights
A2.07	SUBROUTINE CALC(2) Longitudinal and transverse wheel probability distribution
A2.08	SUBROUTINE PAVDES Equivalent single type aircraft operation and unit price of pavement components
A2.09	SUBROUTINE FAM Forecast of aircraft movement for equivalency computation
A2.10	SUBROUTINE HDES Limiting stress and deflection in pavement thickness design
A2.11	SUBROUTINE PCVCAL Compute present cash value

A2.05 Subroutine NDT3

```
TO: 50 600 J=1,ISEPAV
103 IF(K.NE.IPFL(J))50 10 600
```

```
NZ=2.#200.#9.#VALC(KP.10)/SSVAL(J)
104
105
                IF (WZ.LT. WZH(1,1)) 63 TO 520
                IV=PFLESG(1)*.75
106
 107
                60 TO 541
            527 DC 530 1=2.WFtaSG
 100
                IF ( wZ . LT . WZH( 1 , 1 ) ) GC TC 530
 105
                EV = (PFLESG(1) + PFLESG(1-1)) * (NZ - NZH(1, 1-1))
 111
               +/(W2H(1,1)-UZH(1,1-1))+PFLESG(1-1)
 11.1
 112
                G. TO 540
 113
            530 CLINTINUS
 114
                EV=PFLESG(NFLESG) *1.25
 115
            540 IF (MORAIN(J). EQ. MNERM) GC TO 550
 116
                J1=ISUPAV+J
 117
 118
                EPAV(II) = SEVAL(J)
 115
                [SU3([1])=[V
                ESUB(J)="V/.6
 12:
 121
                CU TO 560
 122
            55' IS=1SEPAV+U
                PPAV(J)=SEVAL(J)
 123
                1 SUB(J)=5V
 124
                II=ISUPAV4J
 125
                6508(II)=.c#EV
. 126
            56 / 18 (ES JU(15) - GT - PELESO(1) 160 TO 570
 127
                x2A=x2H(1,1)+x25*(x2H(1,1)-x2H(1,2))
 328
 129
                GO TO 590
            570 00 530 I=2 mFLESG
 130
                IT (ESUB(IS).GT.PFLESC(I))GD TO 580
 131
                h 2A=( \ZH(1,1)-xZH(1,1-1)) *(LSUE(15)-PFLESG(1-1))
 132
 120
               +/(PFUUSG(1)-PFUFSG(I-1))+WZH(1,1-1)
                60, 10, 59;
 134
            580 COSTA (U.)
 135
                ...ZA# >Zn(()+Nf(H3G)-.25*(kZH((),NFLCSG-1)+HZH((),NFLESG))
 120
 157
            Some PAVITS ) = STVALID) *KZZAZA
 109
            6Co Carrivilla
```

A2.06 Subroutine CALC(1)

```
123
         C *** APY
124
               APY(I)=0
125
               N=11 kHで見し(I)
126
               DO 420 J=1.N
               IF(WHITELX(I,J).NE.O.1GG TO 420
127
               APY(I)=APY(I)+EXP(-(WHEELY(I,J)/(12.*450.))**2/2.)
128
129
           420 CCHILIUE
               DO 450 J=1.3
136
         C *** RADIUS FACTOR
151
100
               RADIJS(1,J)=50RT(.31820987EC*DPWGT(L,J)*AIRC(1,5)/AIRC(1,6))
155
               FACTUR(I,J)=0.
                T1=(3./8.) **2
134
               12=(15./48.)**2
135
               00 440 K=1.N
136
                WX= SURT (ABS (WHF & LX (I, K) **2) + ABS (WHEELY (I, K) **2))
137
                IF(KK.82.0.)68 TO 430
138
139
                FACTOR(1.J) = FACTOR(1.J)+1.
140
               GU TO 441
           430 YK=(RADIUS(I,J)/WX)**2
141
                WK=1.5716*(1.+.25*YK+T1*YK**2+T2*YK**3)
142
                wil=1.5703*(1.-.25*YK-T1*YK**2/3.-T2*YK**3/5.)
145
                FIFM= 2. /3.14159*WX/KADIUS(I,J)*(wE-(1-YK)*WK)
144
                FACTOR (I, J) = FACTOR(I, J) +FIRM
145.
           440 CUNTIBUE
146
147
           450 Cdl. 71808
149
                APY (1) = APY(1) *.03157*RADIUS(1,2)/12.
145
           466 CLINTERUE
                10=10181(1)
150
                HADIUS (20.1)=SURT (.3183 0987 E0 #CUP WGT (1) *AIRC(ID.5)/AIRC(ID.6))
151
15%
         C *** APX
                DO 560 K=1,NBAND
15.
                I SP X=RTYPE*(K-))
154
155
                DO 55 / LA=1,MTYPE
                L=IAPX+LA
156
157
                00 540 M=1,NOPWGT
158
                I=IAIRU(M)
                IF (1.LE.G) GC TG 540
155
                NW=NWHEEL(I)
160
                Di 53: J=1.3
161
                APX(I,J,L)=0.
16
               10 52 N=1.NW
162
                APX(!,J,L) = APX(!,J,L) + (AP(-)0.8167*)
104
              4 (WHFFLX(I,W)/(!2.*BAND(K,LA)))**2)
16:
           525 017 11 400
166
                /PX([,J,E)=:PX(I,J,E)=5.2885=fE=01US(I,J)/(12.*BAND(K,EA))
101
               TOTAL STREET
162
            46 (0.7110)
160
```

E .

A2.07 Subroutine CALC(2)

```
56
        C *** PAVL CODE LAYE
57
              DC 250 I=1.NPAVE
58
          280 NENLAYER(I)
55
              DC 250 J=1.N
60
              DO 24. K=1, NLAY
61
              IF (LAYER (I. J. I) . NE. MLAY (K. I) ) GO TO 240
62
               IF (LAYFR(I, J, 2) - NE-MLAY (K, 2) 160 TO 240
63
              ILAYER(I,J)=K
              IF(EVAL(I,J).LT.1.) EWAL(I,J) = VALAY(K,1)
64
55
               1F(PDIS(I,J).LT.D.c01)PCIS(I,J)=.65-.08*ALGG10(EVAL(I,J))
              GO TO 250
66
67
          24) CUNTINUE
68
        C ### EKRER
69
          250 CONTINUE
7 C
          260 CONTINUE
71
        C *** AIFC CODE TOW
72
              U. 255 I=1, MAIRC
73
              IAUF(1)=0
74
              IR4NSE(1)=0
75
          255 CUMTIBUE
76
              DG 270 K=1,NOPWGT
              1=IAIRC(K)
77
              IF(J.LE.0)GC TO 270
7.3
75
              IKANO^*(I)=I
84
              IFILE WAS (K.1) . ME. IPLANKICO TO 261
              LRANGI(K,1)=MR4NG(I,1)
81
              LKANSI(K, 2) = 19ANS(1,2)
62
€. .
          201 DC 252 J=1.4
8:
              IF (LEANSE (K.)). No. MRANGE (J)) GO TO 262
              LaCapaca (I)=J
25
              CU TO 202
56
87
          202 CONTINUE
8.3
          263 IALF(I)=1
35
              IF(LALF(K, 1).Fu.MALF(2))IALF(1)=2
90
              t=12tF(1)
9:
              J=IRA (03(1)
92
               IF (LALI (K. 1). EQ. IBLAKK. AND. TOW(J, 1, L). GT. 1.
93
             +.AND.CFJGT(K,1).LT.1.)L/LF(K,1)=MALF(1)
94
              1F(Tru(J,I,L).LT.1..ARG.CPNGT(K,1).LT.1.)OPNGT(K,1)=AIRC(I,1)
95
              1F ( PAGT (K, 1) . LT. 1.) SPEGT (K, L) = TOA(J, I, L)
96
              97
             +%(UPSIT(N+1)-ALAD(1+3))/(ALAD(1+1)-ALAD(1+3))+ALAD(1+3)
90
              IF(LP + GT (K+2) - LT - 1 - JUPWGT (K+3) = 1 - 5 * UPWGT (K+2)
. 99
          27% CUNTINUE
```

A2.08 Subroutine PAVDES

```
:350
          1317 ELAY=EVAL(KM, IHSA)
 351
              EBOT=EVAL(KM, NL)
          1318 CCNSTA=VALC(K3,2)*SQPT(ELAY)*VALC(KB,3)*(1.-VALC(KB,4))
 352
              DO 1330 1A=1.NOPWGT ...
 353
              I=IAIRC(IA)
 354
              IF(1.LE.0)GU TO 1330
 355
              DG 1320 J=1,3
 356
 357
              ANS(I,J)=-(ABS(STRFD(KAA))-ABS(STRFAM(I,J)))/CONSTA
          1320 CUNTINUE
 358
          1330 CONTINUE ...
 355
              ANS (20,1) =0.
 36C
              DU 1350 IA=1,NUPWGT
 361
               I=IAIRC(IA)
 362
               IF(1.LE.0)GG TO 1350
 363
              DO 1340 J=1.3
 364
              FACTOR(I, J) = x Z FAM(I, J) / k Z w(I, J)
 365
              PRESS = AIR C(I+6) * FACTOR(I+J)
 366
              WO=2. *PRESS*RADIUS(I, J)*VALC(KB, 10)/EBOT
 367
              D4=1./VALC(KB.8)....
 368
              DUDEF=WJ**(1.-D4)*WZFAM(I,J)**D4*VALC(KB,7)**(-D4)
 369
 370
              AND (I, J) = DCDEF
 371
         1340 CUNTINUE
 372 .
         1350 CONTINUE
              FACTOR(20,1)=WZFD(KAA)/WZWFD(KAA)
 373
 374
              PRESS=AIRC(ID,6)*FACTOR(20,1)
 375
              WD=2.*PRESS*RADIUS(20,1)*VALC(KB,10)/EBOT
              AGD(20,1)=WC**(1.-D4)*WZFD(KAA)**D4*VALC(KB,7)**(-D4)
 376
 383
              DO 1376 I=1.NPAVHO
              IF(IPAVL(I).EQ.(CL)GO TC 1374
 384
              IF(IPAVE(I).GT.ICLIGC TC 1372
 385
 386
              REWIND 9
              ICL = 3
 387
         1372 ICL=ICL+1
 388
              IF(IFAMDS(ICL,1).LE.O)GC TO 1372
 389
              READ(9)((ANS(IA,J),AND(IA,J),FACTOR(IA,J),IA=1,20),J=1,3)
 340
              If (IPAVL(I).NE.ICL)GG TC 1372
 391
          1374 WRITE(12)((ANS(IA,J),ANC(IA,J),FACTOR(IA,J),IA=1,20),J=1,3)...
 392
 393
          1376 CONTINUS
              ENDFILE 12
 394
 395
              REWI'ID 12
              REWIND 9
 396
 397
              PEW140 L18
 398
              NSUP#FINA(6)
              ASCM=(FINA(4)+FINA(3)+FINA(2))+FINA(2)*(FINA(3)+FINA(4))
 399
              PCVAMC=FEDAT(MSLP-1)#(1.4FLDAT(MSLP-2)#ASCM/2.#
 400
 401
             +(1.+FLCAT(NSLP-3)*ASCM/3.))
 402
              AIR6V=1.-1./(1.4FINA(1))
              PUVICC-1.-(FIMA(5)-2.)*(FIMA(2)-A IRBV)/2.*
 403 -
             4(1.-1:11A(5)-3.)*FINA(21/3.)
 464
```

A2.09 Subroutine FAM

```
90
                                  00.415 J=1.3
                                  AKSA(I,J)=10.**(ANS(I,J)/(U)/*RSF/(I.+U)(LOC, ITYP))))
  91
  92
                        415 CONTINUE
                                 DO 420 J=1.3
  93
  94
                                  CUNST = 2.28
  95
                   C
                                  Cl= .01
                                  DD=SQRF(D1(LOC, ITYP)/(1.+DI(LOC, ITYP)))
  96
                   C
.97
                   (
                                  VV=DD*VEL(LOC,ITYP)+60.*(1.-DD)
                                  \XX=8.0\perpressure(I.1)\results \text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\texit{\text{\texi}\tint{\text{\tirit{\texit{\text{\text{\text{\ti}\tint{\text{\text{\tert{\text{\ti
  43
                   (
  99
                   (
                                  AK=CUGST/VV*D1(LUC, 1TYP)/SURT(AIRC(1,7)) -
100
                                  AAK=10.**(VALC(KP,5)*ALLG10(AK/VALC(KP,6)))
                   (.
101
                                  DH=12.*AAK*SART(XX*RAD1US(I,J)/12.)
                   C
                                  ANDB(I,J) = (DN-C1)/AND(I,J)
192
                                  AndA(I,J)=10.**((And(I,J)-And(20,1))/And(I,J))
102
104
                        42 CONTINUE
                                  IF (KPAV(KP).LE.1) ARITE (6, 4( )DI(LOC, ITYP), VEL(LOC, ITYP),
105
                                +(FACTOR(I, 1), J=1,3), XNZ(1), (RADIUS(1, J), J=1,3), AIRC(1,7),
1:6
                   C
                                +VALC(KP,5),VALC(KP,6)
1 - 7
                   C
103
                          46 FORMAT(1X,12F11.5)
109
                        425 COMTINUE
116
                   (
                                  XX=8.6*FACTOR(20,1)+XMZ(ID)/FADIUS(20,1)
                                  AK=CONST/VV#DI(LOC, ITYP)/SQRT(AIAC(ID, 7))
111
112
                   •
                                  AAK=10.44 (VALC(KP.5)4ALEGIO(AK/VALC(KP.6)))
1:3
                   C
                                  ON= 12. ** AAK * SQRT(XX * RADIUS(20,1)/12.)
114
                   C
                                  ANDB(20,1)=(UN+C1)/400(20,1)
115
                                  AMUA(20,1)=1.
                                  IF(KPAV(KP).LF.1)
116
                   (.
                   (
                                +NAITE(6,30)((AND(I,J),J=1,3),1=1,12)
117
118
                                  IF(KPAV(KP).LE.1)
                   1.
                                +aPINE(6,30)AHD(20,1)
119
                           20 FC4 MAT(1X, 196313.5)
                   C
120
                                  00 614 K=1,6ST1
121
                                  DU 440 IA=1, NEPWGT
123
                                  1=1AIRCLIAL
123
                   1
                                  IF(1.LE.0)GC TO 440
124
                   C
125
                                  DE 450 J=1.3
                   C
                                  A CDA(T.J)=).
126
                                  IF (ATM(X, 14, J).LB.O.COO11GC TO 430
127
                   (
                                  4 (1, 1) = 10. **(1 4 AOB (20, 1) - ANDS (1, J))
128
129
                                +1
                                4836.530(ATA(K,1A,J)#APX(I,J,IAPX))/ANOB(20,1))
130
                   6 400 CE ITERUE
131
130
                   C 440 CUNTIBUT
                   ር ተተተ 4285
133
                                  D. 450 J=1.0
134
                        450 5 m2 MUV(J) = 0.
130
                                  " 47 ) TA=1 , TOPNOT
136
                                  1-15.8((12)
137
                                  18 (1.Le. 101 16 47d
138
139
                                  0 4m J=1.2
140
                                   `JS(1,,))=ATA(K,)A,J)*ANSA(I,J)*AAX(1,J,IATA)-
```

A2.09 Subroutine FAM (cont'd)

```
SEGMOV(J) =SEGMOV(J) +ATM(K,IA,J) *ANSA(I,J) *APX(I,J,IAPX)
1+1
          460 CONTINUE
142
              J=3
143
              .0=(L.I)20E
144
               IF(Nu*GT*2)EUS(I*J)=ATM(K*IA*J)*ANSA(I*J)*APX(I*J*IAPX)
145
146
              IF (HI.GT.2) SECHOV (J) = SECHOV (J) + ATM(K, IA, J) * ANSA(I, J) *
147
              +APX(I,J,IAPX)*APY(I).
148
          470 CCD11NUE
145
              AANSEK-LUCT #7.
155
              DE 480 J=1,114
151
               AANS(K, EDC) =AANS(K, EDC) +SEGMUV(J)
152
          480 COUTT WE
153
               AALS(K.LCC)=AANS(K.LGC) #SPERC(LGC)
154
        C *** AM.U
155
               DU 490 J=1,3
150
          490 DECHCV(J)=0.
151
               DU 513 IA=1,MOPRGT
158
               I=IAIRC(IA)
155
               IF(1.LE.9)GC TO 510
160
               DC 500 J=1.2
161
               .0=(L,I)G03
162.
163
               ALDE T.
               ip(ATM(X, 12, J).GT.0.1)
104
              +ALMS=ALCGIO(ATM(K,IA,J)*APX(I,J,IAPX))
165
               14 (4E MD.GT.3.)AEMO=2.
150
              TF(ATA(X, IA, J).GT.0.1)
167
              +Cub(I,J)=(ANDA(I,J)**ALND)
164
              165
               DLOM_{UV}(J) = DECMOV(J) + EQD(I,J)
17.
           SCO CONTINUE
171
               J = 3
172
               .)=(L,I)GUC
175
               ALHE= ).
177
               IF (Em. GT. 2. A (C.ATM(K, IA, J).GT.O.1)
175
              +ALNL=ALGGIE (ATM(K, IA, J)*APX(I, J, IAPX)*APY(I))
176
               IF (ALIAD.GT.D.)ALMO=3.
177
               IF (GG.GT.2.AND.ATM(K, IA,J).GT.C.1)
178
              +LQD(I,J)=(ANDA(I,J)**ALND)
179
              (I)YSA*(XAVI 'f')XAV*(f'VI'') LTTTT
18
               18 (NA.GT.2) DEQMOV(J) = DECMOV(J) + JQ D(1.J)
161
           51. CONTINUE
182
               AAFELK, LLC)=0.
 163
               OC 527 J=1, NW
 30,4
               A IN UTK , LECO) #AMADEK, LCC) 4DEGMOV(J)
 185
           520 COLTINUE
 1,56
                AAR D(K, LCC) WAAND(K, LCC) #SPERC(LCC)
 157
```

A2.10 Subroutine HDES

```
C *** STRESS LIMIT
51
. 52
             NL=NLAYER(KM)
53
             NL1=NL-1
.54
             DU 190 J=1.NL1
...55_..
          STRL(K,LOC,J)=SQRT(EVAL(KM,J))*(1.--YALC(KP,3.)*
            +ALOG10(AANS(K, LEC)))/(1.+DI(LOC, ITYP))
56
57
             STRL(K,LOC,J) = STRL(K,LCC,J) *VALC(KP,2)
             CVERSF=VALC(KP,1)
58
             IF(LUC.GT.1)UVERSF=VALC(KP.9)
59
             STRL(K,LOC,J)=STRL(K,LCC,J)*OVERSF*(1.-VALC(KP,4))
60
61 ...
         190 CONTINUE.
             IF(KN.LE.O)GO TO 197
62
63
             NLA=NPSLAY(KN)
64
             NLA1=NLA-1
65
             DU 195 J1=1,NLA1
             J=J1+NL1
65
             STRL(K,LOC,J) = SQRT(PSLE(KN,J1)) * (1.-VALC(KP,3)*....
67
            +ALOGIO(AANS(K,LOG)))/(1.+DI(LOC,ITYP))
68
69
             STRL(K,LOC,J) = STRL(K,LOC,J) *VALC(KP,2)
             CVERSF=VALC(KP,1)
7 C
71
             IF(LOC.GT.1)OVERSF=VALC(KP,9)
             STRL(K,LUC,J) = STRL(K,LOC,J) *OVERS F*(1.-VALC(KP,4))
72
         195 CONTINUE
73
       C *** WZL
74
         197 CONST=2.28
75
76
             C1=.31
77
             XX=8.6*FACTCR(20,1)+XNZ(ID)/RADIUS(20,1)
             PRESS=AIRC(ID,6)*FACTOR(20,1)
78
79
             DD=SJRT(DI(LGC,ITYP)/(1.+DI(LGC,ITYP)))
8 C
             VV=CD*VEL(LCC, ITYP)+60.*(1.-DD)
81
             AK= CONST/VV*DI(LOC, ITYP)/SQRT(AIRC(ID,7))
       C
             WRITE(6,20)KP, AK, VALC(KP,6)
82
          20 FURMAT(1X, 15, 2F10.4)
83
             AAK=10.**(VALC(KP.5)*ALCG10(AK/VALC(KP.6)))
84
             DH=12.*AAK*SURT(XX*RADIUS(20,1)/12.)
85
86
             EBGT=EVAL(KM, NL)
             IF (KN.GT.O) SUOT=PSLE(KN,NLA)
87
88
             WG=2.*PRESS*RADIUS(20.1)*VALC(KP.10)/EBOT
             D3= VALC(KP,7) *WO**(1.-VALC(KP,8))
89
90
             IF(AAND(K,LOC).LE.10.) NZL(K,LOC)=(DN-C1)**VALC(KP,8)
91
             IF(AAND(K.LCC).GT.10.)
92
            +wZL(K,LOC)=((BN-C1)/ALGGIO(AAND(K,LOC)))**VALC(KP.8)
93
             D4=1./VALC(KP,8)
94
             DODEF = VALC (KP.7)**(-D4)
             IF(NXSL.LE.1) WZL(K.LOC) = (DN-C1)
95
96
       C 444 WE AND DO TO BE CALCULATED LATER
97
       C *** SHOULD USE ESUP
```

```
360 IST=IST-1
.169
17C
         370 I1=IEST+IES
171
             ESUP(K)=ESUB(II)
172
             NL=NLAYER(KM) . . .......
-173
174
             NL1=NL-1
             PRESS = AIR C(ID, 6) * FACTUR(20,1)
175
             176
             D3=VALC(KP,7)*WO**(1.-VALC(KP,8))
177
             U4=1./VALC(KP.8)
178
             LOC 2=2
179
             IF(NXSL.LE.1)GO TO 501
             DO 373 LUC=1.LUC2
180
             WZLIM(K,LOC)=D3*WZL(IST,LOC)
181
182
             TAND(K,LOC)=AAND(IST,LOC)
183
             TANS(K, LOC) = AANS(IST, LOC)
             184
             STRLIM(K, LOC, J) = STRL(IST, LOC, J)
185
186
          371 CONTINUE
187
             1F(KN.LE.0)GO TO 373
             DG 372 J1=1.NLA1
188
189
             J=J1+NL1
            STRLIM(K, LOC, J)=STRL(ISI, LOC, J)
190
191
         372 CONTINUE
192
         373 CONTINUE
        C *** INTERPOLATE EVALUE
193
194
             IF(ESUB(II).GT.ESUBG(1))GO TO 375
195
        C *** ERRUR
         375 DC 380 I=2.NE
196
             1F(ESUB(I1).EQ.ESUBG(I))GU TO 390
197
             IF(ESUB(II).LT.ESUBG(I))GD TO 410
198
199
         380 CUNTINUE.
20C
        C *** EDROR
201
             I = NE
             CU TO 410
202
203
          390 DC 400 N=1.NHG
204
             WZ(K) = WZH(N \cdot I)
             STR(N) = STRH(N+I)
205
         400 CENTINUE
206
207
             Gu TO 422
          410 DU 420 N=1,NHG
. 208
209
             WZ(II) = (WZH(II, I)-WZH(N, I-1))*(ESUB(I1)-ESUBG(I-1))
            +/(FSUBG(I)-ESUBG(I-1))+%ZH(N+I-1)
21 C
             STR (4) = (STRH(N,I) - STRH(N,I-1)) + (ESUB(II) - ESUBG(I-1))
211
212
            +/(ESU3G(1)-ESUBG(I-1))+STRH(N,I-1)
213
          420 CENTINUE
          422 DO 500 J=1.2
214
             THE AZELIMEK, J) . LT. WZ(1) JGD TO 425
215
             HDES(K,J)=HVAL(KM,1)
216
217
             GC TO 460
 218 .
          425 DO 430 N=2+NI4G
219
             IF ( AZLIM (K. J) .GE.WZ (N)) GO TO 450
220 .
         430 CONTINUE ....
```

```
HDES(K.J)=HVAL(KM.2)+HVAL(KM.3)/2.
221
222
              ICRIT(K.J)=-1
223
         ____ GÚ. TÚ. 500 .
          450 HDES(K.J) = (HGRID(KM.N) - HGRID(KM.N-1)) * (WZLIM(K.J) - WZ(N-1))
224
             +/(WZ(N)-WZ(N-1))+HGRIO(KM.N-1)
225
. 226
        .460 TH= IPAVHS(KI)
                           1F(KN.GT.0)1H=1H+NL1
227
228
              JF(STRLIM(K.J.IH).LT.STR(1))GO TO 465
225
             H=HVAL(KM.1)
23 C
              GC TO 480
231
          465 DO 470 N=2.NHG
.. 232
        .....IF(STRLIN(K,J,1H).GE.STR(N).JGD TD.475.....
233
          470 CONTINUE
234
             HDES(K.J) =HVAL(KM.2)+HVAL(KM.3)/2.
235
             GO TO 500
236 /
          475 H=(HGRID(KM,N)-HGRID(KM,N-1))*(STRLIM(K,J,IH)-STR(N-1))
237
..238
             239
          480 [CRIT(K.J) =-1
              1F(HDES(K,J).GT.H)GC TO 500
24 U
241 ...
             HOES(K,J)=H
242
              ICRIT(K,J)=1
243
          500 CONTINUE
244
             GO TO 510
245
          501 IP=IPFL(11)
              IF(ESJP(K).GT.PFLESG(1))GO TO 502
246
              WZ(1P)=#ZH(IP,1)+.25*(WZH(1P,1)-WZH(IP,2))
. 247
248
              STR(1P)=STRH(1P,1)+.25*(STRH(1P,1)-STRH(1P,2))
249
             GD TD 504
25 C
          502 DO 503 1=2.NFLESS
251
              1F(ESUP(K).GT.PFLESG(I))GO TO 503
252
              wZ(19)=(WZH(IP,I)-WZH(IP,I-1))*(ESUP(K)-PFLESG(I-1))
253
             +/(PFLESG(1)-PFLESG(I-1))+WZH(IP,I-1). _____
              STR(IP) = (STRH(IP,I) - STRH(IP,I-1)) *(ESUP(K) - PFLESG(I-1))
254
255
             +/(PFLESG(1)-PFLESG(1-1))+STRH(IP, I-1)
256
             GL TO 504
257
          503 CONTINUE
258
              *Z(IP)=YZH(IP.NFLESG)-.25*(WZH(IP.NFLESG-1)-WZH(IP.NFLESG))
..259
              STR(IP)=STRH(IP,NFLESG)+.25*(STRH(IP,NFLESG-1)-STRH(IP,NFLESG))
260
        C 504 DCDEF=W0**(1.-D4)*W2(1P)**D4*VALC(KP,7)**(-D4)
261
          5C4 DODEF=ESUB(11)/(VALC(KP.7)*EPAV(11))
262
              DCDEF=wU+10.**(D4*ALCG10(DCDEF))
263
              TAND(K.1) = AAND(IST.1)
264
        C
              TAND(K.2)=10.++(WZL(IST.1)/0JDEF)
265
              TAND(K,2) = (WZL(IST,1)/OCDEF)
266
              IF( TAND(K, 2).GT.30.)TANC(K, 2) = 30.
267
              TANC(K,2)=10.**TAND(K,2)
268
              TANS(K.1) = AANS(IST.1)
269
              IH=IHS(IP)
270
              SIGY=VALU(KF.1)*(1.-VALC(KP.4))*VALC(KP.2)*SQRT(EVAL(IP.IH))
271
              SIGY=SIGY/(J.+DI(1,ITYP))
272
        (
              TANS(K,2)=10.**(($1GY-$TR(TP1)/(VALC(KP,3)*$IGY))
273
              1ANS(K,2)=((S1GY-S1K()P))/(VALC(KP,3)*S1GY))
274
              TANS(K,2)=10.**TANS(K,2)
275
          510 CUNTINUE
```

A2.11 Subroutine PCVCAL

```
47
              Dr. 300 la. 6-1.2
              12 225 27 1. CASTL
43
              1/35A=12A5H5(71)
14.14
              In (NO. La. o) at AY=CVAL(KR. 196A)
45
              TECK 1.61. Clay AY=PSUE (KN. THSA)
400
41
              If (KALULEO) IHSA=I HSA+NLAYER (KAL-L
              12# 145 (< 1)
4 8
4',
              The Heave (KA, Id)
              Alucia, Licia = Cistika) + HGES (K, LOC) #UL(IL)
ンじ
51
              JUSTR=VALC(KP,2)#SQRT(ELAY)#(1.-VALC(KP,4))
52
              minsiteousia*(1.-valc(KP,3)*ALDG10(TAMS(K,LDC)))
52
              GVEESF=VALC(KP.1)
              IF (EDG. AT. 1) GVEF SE=VALC (KP',9)
54
55
              ZAC=VALC(KH,A)*OVERSF*(LLSTR-XOSTR)/(ULSTR-STRLIM(K,LOG,IHSA)
263
             +/UVERSE)
51
              AMC(R,LOC)=2MC@UL(IL)
63
              PCV(K,LCC)=AAC(K,LGC)*PCVAAC+ALCC(K,LCC)*PCVICC
54
          200 CONTINE
60
          多的 医冠目管疣
1.1
              11 (131A(14FAC,2).JT.D.GC)SG TG 320
€.
              APOV(1)+PCV(1,1)
              ASC ((2)=26v(1,2)
6.
64
              65 To 930
6:
          323 00 400 106=1,2
              a26v(t36)=1.
1.1.
01
              U.J. 350 Y=1.355T1
              CPCV(LCC)=APCV(LOC)+PCV(K+LOC)*(ASTACK+1)-ASTACK))
5 ..
69
          350 CavIII/Ja
76
              APCY(LCC) = APCY(LOC)/(ASTA(NAST)-ASTA(1))
71
          400 COLTINUE
```